Centre Technique de Coopération Agricole et Rurale ACP-UE
Technical Centre for Agricultural and Rural Cooperation ACP-EU
CTA

Sustainable agro-pisciculture systems in sub-Saharan Africa

Summary Report of a CTA study visit

Malawi, 15–26 November 1999

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Synthesis Report

Technical Centre for Agricultural and Rural Cooperation (ACP-EU)

The ACP-EU Technical Centre for Agricultural and Rural Cooperation (CTA) was established in 1983 under the Lomé Convention between the African, Caribbean and Pacific (ACP) States and the European Union Member States. CTA's tasks are to develop and provide services that improve access to information for agricultural and rural development and to strengthen the capacity of ACP countries to produce, acquire, exchange and utilize information in these areas. CTA's programmes are organized around three principle themes: strengthening ACP information capabilities, promoting contact and exchange of information among partner organizations and providing information on demand.

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Introduction

Background

Fish farming is a relatively new activity for small-scale farmers in sub-Saharan Africa. It was first introduced in the 1950's and 1960's as a way to improve the availability of fish in rural households for home consumption and income generation. The results of many years of research and the experiences of many development projects have shown that fish farming can make a contribution towards improving rural livelihoods, however, many challenges remain, including the following issues:

- Most areas where small-scale fish farming has been promoted, have experienced cycles of adoption and neglect, corresponding to the amount of effort expended by the extension services.
- Fish farming extension is expensive and difficult to cover because suitable areas are often widely scattered.
- In many countries fish farming falls within the remit of several organisations; it fits better with agriculture but is often the responsibility of a Department of Fisheries (dealing mainly with open water fisheries) in a different Ministry

Malawi has been host to a number of fish farming research and development projects over the last 20 years. It has areas with high potential for small-scale fish farming and several thousand farmers who are benefiting from the integration of fish into their farming systems. Interest in both small-scale and commercial fish farming is increasing as fish stocks from natural water bodies are reducing through over exploitation.

In late 1998/early 1999, the Technical Centre for Agriculture and Rural Cooperation(CTA) indicated that they would like to support a study visit focussing on integrated agriculture-aquaculture farming systems and preparatory investigations identified Malawi as a suitable venue. The study visit on Sustainable Agro-Pisciculture Systems was organised by CTA in collaboration with the Department of Fisheries of the Malawian Ministry of Natural Resources Environmental Affairs and the Malawi Office of the International Center for Living Aquatic Resources Management (ICLARM).

The overall objective of the study visit was to focus on the development of sustainable strategies for the dissemination of knowledge about integrated agriculture-aquaculture farming systems as a realistic option for smallholder farmers by analysing the approaches used in Malawi and sharing experiences from other countries in sub-Saharan Africa. Specific objectives were as follows:

- To assess the current status of fish farming in Malawi, in particular, whether the extension systems used in the past and at present are sustainable.

- To identify the research and extension needs of the Malawian smallholder fish farming sector.
- To compare the Malawian experience with those from other countries.
- To propose action plans which can be undertaken by the participants after the visit to enhance the effectiveness of their involvement in their own smallholder fish farming sectors.

Organisation

Potential participants for the study visit were identified through consultation with FAO, ICLARM, SADC and other organisations who are active in fish farming research or development in the anglophone countries of sub-Saharan Africa. Priority was given to representatives from countries where there is an active small-scale fish farming sector, or good potential for its development. The aim was to identify people who have an important role to play in the development of small-scale aquaculture in each country Another priority was to have representative balances of research and extension staff, government and NGO staff as well as a reasonable gender balance. Potential participants were contacted in late June or early July, and if interested, were forwarded registration forms by CTA. They were also asked to forward to the technical consultant a 2 page summary of a paper to be presented on the opening day of the study visit dealing with some aspect of aquaculture in their country by the end of September.

Fourteen participants drawn from nine subsaharan countries (Kenya, Malawi, Mozambique, Nigeria, South Africa, Tanzania, Uganda, Zambia and Zimbabwe) attended the study visit (see annex 1: list of participants).

Study visit opening

The study tour started in Lilongwe on the 15th of November with a one-day workshop where the study visit was opened and the participants gave presentations on the status of aquaculture in each of the countries represented. The guest of honour and opening address was by the Honourable Alice Sumani, MP, Deputy Minister for Natural Resources and Environmental Affairs accompanied by Mr. B. Mbewe, Principal Secretary, Ministry of Natural Resources and Environmental Affairs.

Country presentations

Historical background

For many centuries, open water fisheries have been very important as major food sources and for trade in most of the countries of sub-Saharan Africa. In contrast, aquaculture has only been introduced in the last 50 years and plays a fairly minor role. The first wave of interest in small-scale fish farming was in the late 1940s and the 1950s when it was realised that farmers could build simple ponds and stock them with tilapia to produce fish for consumption by the household or for sale. Many of the colonial governments built fish farming stations to support these efforts, Sagana station in Kenya started in 1948; Nchenachena station in Malawi started in 1953; Kajjansi station in Uganda started in 1953. In general, fish farming was-enthusiastically adopted by farmers in each country Uganda, Kenya, Malawi, Tanzania and Zambia were all reported as having more than 1000 fish ponds by the start of the 1960s. However, in most cases, the amount of fish being produced was very low, particularly when compared to the quantities of fish caught from lakes and rivers.

Interest and uptake of small-scale fish farming in sub-Saharan Africa has continued over the years, often due to active campaigns or projects. But also many farmers have abandoned it, meaning that now, the number of active farmers and the amount of fish produced has not risen much beyond the levels experienced in the mid 1960s. This is in direct contrast to the situation in Asia where aquaculture production has boomed over the last few decades. Some of the reasons for this apparent lack of success are technical, such as poor species, shortage of suitable sites or lower than optimal temperatures. However, most are socio-economic such as lack of resources (cash or materials) for fish farming inputs, inadequate support (extension services, fingerling supply) for fish farmers and political and/or economic instability

Species

The most widely practised small-scale fish farming system in the Region is pond culture of tilapia. The main species used varies from country to country as shown in table 1. The nile tilapia ***(Oreochromis niloticus)*** is the most widespread. The original distribution of this species was the Rivers of West Africa, most of the Nile system as far South as Lake Tanganyika (except for areas above Murchiston Falls such as Lakes Kioga and Victoria) and some scattered Northern populations in Ethiopian lakes and Israel. Because it has proved to be the

best pure tilapia species for aquaculture, with fast growth rates and relatively late maturity, it has now been introduced well beyond this range in Africa and to most other parts of the World where warm-water fish farming is possible.

The first introduction to natural water bodies was to Lakes Victoria and Kioga in the late 1950s, where it has now become the dominant tilapia species. Aquaculture escapes mean that it is now found in parts of the Zambezi system, including the Kafue, Lake Kariba and the middle Zambezi. Of the countries represented in the study visit, only Malawi and South Africa have not officially sanctioned the use of nile tilapia for aquaculture, on the grounds that it may result in adverse environmental impacts, particularly that it would hybridise with native species resulting in a loss of biodiversity.

Over the years there has been an interesting change in attitude to the use of exotic species. During the colonial period, introductions were widespread, mostly for angling, such as trout and bass. During the **1960s** and **1970s** further introductions were made for sub-Saharan African fish farming, particularly common carp, other chinese carps and transfers of tilapia species. After this period, authorities in most countries became less willing to allow new introductions, largely because of widely quoted adverse environmental impacts from fish introductions in Lake Victoria (nile perch), South Africa (carp) and Australia (carp).

The tilapia species ***Tilapia zilli*** and ***T. rendalli,*** are often used in polyculture ponds because they are mainly herbivorous, so are easy to feed. Other species of Oreochromis are used because they are the most widely available species in the area, such as ***Oreochromis andersonii*** and ***Oreochromis macrochir*** in Zambia, ***Oreochromis shiranus*** in Malawi and ***Oreochromis mossambicus*** in Zimbabwe.

The most widespread non-tilapia species are common carp ***(Cyprinus Carpio)*** and African catfish ***(Clarias gariepinus).*** Common carp was introduced to most sub-Saharan African countries in the **1950s** and **1960s.** It is one of the most widely cultured fish world-wide. Current distribution in the Region is patchy, because it does not breed readily in ponds. Where there are regular supplies of fingerlings from hatcheries it is often preferred to tilapia because it grows quickly, and to a large size without over-reproducing and stunting. Even a resource-poor farmer can grow a few big fish with very few inputs. Although there are no clear examples of environmental degradation caused by common carp in tropical sub-Saharan Africa, concern has been voiced due to experiences in Australia and South Africa. Carp are said to have increased the turbidity of river systems by their habit of digging into bottom sediments. The turbid water made the environment unsuitable for other species thereby resulting in a loss of biodiversity. Malawi has taken a strong stance against carp, banning it from the Lake Malawi catchment and discouraging its use in other areas. Uganda is reconsidering its position with regard to the promotion of carp culture.

The techniques for African catfish culture were developed in the **1970s.** It does not spawn easily in ponds but the methods for breeding in hatcheries are well established. The most difficult stage is rearing from fry through to the fingerling

stage. Young fry grow best on live zooplankton feed and can be very cannibalistic. Hatcheries have to be well managed if they are to achieve significant production of fingerlings. Once past the fingerling stage, African catfish grow fast and to a large size. Although commonly used in polyculture ponds with tilapia, they can also be grown in monoculture only using animal manure and supplementary feeding. *Clarias gariepinus* is native to all the countries represented in the study visit.

Table 1. Main species used in aquaculture in each country.

Country	Main tilapia species used	Other main species
Ghana	*Oreochromis niloticus*, *Sarotherodon galileus*	*Clarias gariepinus*, *Heterobranchus spp.*, *Heterotis niloticus*, *Chrysicthys nigrodigitatus*
Kenya	*Oreochromis niloticus*, *Tilapia zilli*, *Oreochromis mossambicus*	*Cyprinus Carpio*, *Oncorynchus mykiss*, *Carassius auratus*
Malawi	*Oreochromis shiranus*, *Oreochromis karongae*, *Tilapia rendalli*	*Clarias gariepinus*
Mozambique	*Oreochromis niloticus*, *Oreochromis mossambicus*, *Tilapia rendalli*	*Cyprinus Carpio*, chinese carps, mussels, *Penaus monodon*, *Penaus indicus*.
Nigeria	*Oreochromis niloticus*	*Clarias gariepinus*, *Heterobranchus bidorsalis*, *Cyprinus Carpio*, *Heterotis niloticus*, *Chrysicthys nigrodigitatus*, *Mugil cephalus*.
South Africa	*Oreochromis mossambicus*	*Oncorynchus mykiss*, *Salmo trutta*, *Clarias gariepinus*, Abalone, mussels.
Tanzania	*Oreochromis niloticus*	Seaweeds
Uganda	*Oreochromis niloticus*, *Tilapia zilli*	*Cyprinus Carpio*
Zambia	*Oreochromis niloticus*, *Oreochromis andersonii*, *Oreochromis macrochir*, *Tilapia rendalli*	*Cyprinus Carpio*, *Clarias gariepinus*
Zimbabwe	*Oreochromis mossambicus*, *Tilapia rendalli*, *Oreochromis niloticus*	*Oncorynchus mykiss*, *Cyprinus Carpio*

Other species used in freshwater culture are the catfish, ***Chrysichthys nigrodigitatus*** and ***Heterobranchus*** spp., mainly in West Africa, as well as the brown trout ***(Salmo trutta)*** and rainbow trout ***(Oncorhynchusmykiss)*** in cool, highland areas. A few other species such as ***Heterotis niloticus*** and ***Lates niloticus*** are sometimes used in West Africa, but are generally stocked from wild sources rather than from stocks bred on farms.

Marine farming is restricted to shrimp culture in countries with an Indian Ocean coastline, farming of shellfish such as mussels and abalone in South Africa and seaweed farming in Tanzania.

Fish Culture Systems

By far the commonest fish farming system in the Region is pond culture. Ponds are built by excavating soil and building up banks to hold water. Crucial aspects of pond construction are the porosity of the soil, the slope of the land and the availability of a perrenial water source. Ponds can vary in size from a few square metres to several hectares, although small-holder ponds in sub-Saharan Africa are generally around 100-200m^2.

Ponds are usually stocked with fingerlings (fish of 5g-25g) and harvested after a period of 4-12 months. Good control of water, feed and fertiliser inputs is required to maximise the efficiency of production. Water should not flow through the pond; it should only be added to make up for seepage and evaporation. Regular applications of organic or inorganic fertiliser encourages the development of plankton which forms the main feed for the fish. Additional feed inputs only need to be low quality cereal brans because plankton is so nutritious.

The commonest problem noted in small-scale fish culture is under fertilisation which can be for a variety of reasons; high rates of water seepage from the pond, the farmer does not apply enough fertiliser or the farmer puts too much emphasis on expensive feeding rather than fertilising. Other common problems are that ponds are not harvested because they cannot be drained and the farmer has no access to a net, and ponds which cannot be stocked because there are no local sources of fingerlings.

One of the best ways to ensure that there is an adequate supply of pond inputs is to integrate fish farming with other agricultural activities. Manure from pigs, poultry, cattle and other livestock can be used to fertilise ponds, although this cannot be done in areas where it is culturally unacceptable. Vegetable wastes and crop by-products can be applied directly or composted before application as feeds and fertilisers. Pond water and mud from the bottom of drained ponds can be used for vegetable plots and crops. These methods have been tried and are being applied in most of the countries represented in the study visit. The joint culture of rice and fish, as practised in Asia has been attempted in sub-Saharan Africa but has not been widely accepted.

Other aquaculture systems have been used in the Region, including cage culture of tilapia, tank culture of tilapia, carp and trout, and rope culture of shellfish and seaweeds.

Research

Technical research on aquaculture has been, and continues to be carried out in most of the countries represented. This has tended to be conducted at research stations, such as Chilanga in Zambia, Henderson in Zimbabwe, Domasi in Malawi, Morogoro in Tanzania, Sagana in Kenya, Kajjansi in Uganda and New Bussa in Nigeria. However, increasingly research is being carried out on-farm in real farmers conditions as it is clear that this has a critical effect on the results and likely adoption of recommendations. A wide range of topics have been investigated including the effects of stocking different species in polyculture and monoculture, the effects of different stocking rates, the effects of different fertilisers and application rates and the results of using different feeds and feeding rates.

Socio-economic research has received much less attention. Interesting issues which have emerged from a number of studies are as follows: Fish farmers tend to be older and less poor than the average farmer. While most ponds are built and owned by men, day-to-day pond management is carried out by women and family members. Fish farming usually only takes up a small amount of time on a daily basis. Theft and predation are serious concerns to many small-scale fish farmers. Marketing is usually not a problem as fish is usually sold at the pond-side. Most farmers are unhappy with the frequency and quality of extension advice and support given to them.

Extension

The way in which aquaculture extension advice for small-holder farmers is delivered differs amongst the countries represented in the study visit. In Kenya, Malawi, Tanzania and Zambia it is primarily the responsibility of the Fisheries Department, however other organisations such as NGOs and Integrated Rural Development Projects may assist. In Uganda and Nigeria, aquaculture extension has been fully integrated into decentralised Agriculture Development Projects which operate at the District level. Many different extension approaches have been used, including Training and Visit (T&V), mass media and group extension.

Current production levels

It is very difficult to provide accurate estimates of fish production from aquaculture, particularly from small-scale, widely scattered ponds. Fish are usually sold by number rather than by weight in rural situations. Most farmers do not

keep good records and many carry out partial harvesting for home consumption. Official statistics often end up being no more than rough estimates derived by multiplying an estimated pond area by an assumed production factor.

FAO statistics are shown in table 2, along with notes on estimated farmer numbers, pond numbers and pond areas from the country presentations.

Future prospects

Prospects for fish culture in most of the countries represented in the study tour appear to be good when set against a background of declining yields from wild fish stocks and resultant shortfalls in fish supply. Generally there is very high market demand so that most rural fish farmers can sell their fish at the pondside, rather than having to take the fish to market or sell to traders. Small scale fish culture in ponds is environmentally friendly, and when integrated into existing farming systems, can provide an extra source of high quality nutrition and cash income for rural households for almost no extra cost.

There are also tremendous opportunities presented by the use of new species and systems. Current research in Malawi is defining the parameters for culture of indigenous cyprinids. Research in West Africa and Zambia has demonstrated the very high growth potential of Heterobranchus and Heterobranchus/Clarias hybrids. Intensive cage culture has been introduced for commercial farming of 5000 t/yr of tilapia in Lake Kariba; perhaps cage farming systems could also be developed for small-scale farmers or community based projects.

On the other hand, despite years of support from international and national development projects, small-scale fish culture has not developed to an extent where it produces a significant proportion of total fish supply in any of the countries in this Region. In their country reports, many of the participants listed constraints. The most commonly noted constraints were as follows:

- Inadequate extension services
- Inadequate technical research
- Unsustainability of investments built up by donor-funded projects
- Inadequate information systems
- Lack of socio-economic information
- Shortage of fingerlings (fish seed)
- Shortage and high cost of fish feeds and other inputs
- Lack of credit

Table 2. FAO Aquaculture production statistics and estimates of farmer numbers, pond numbers and pond areas given in country reports.

Country	1996		Estimated number of	
	Amount (t/yr)	Value ($)	Farmers	Ponds (area)
Nigeria	17944	43387000	n/a	(4439 ha)
Zambia	4770	20038000	5000	10146
South Africa	3454	8492000	n/a	nla
Kenya	605	1373	20000	nla
Ghana-	550	960000	2000	3630 (450 ha)
Malawi	226	219000	3500	nla
Uganda	210	210000	n/a	8—9000
Tanzania	200	344000	n/a *	7464
Zimbabwe	185	733000	n/a	2200 (40 ha)
Mozambique	37	59000	nla	nla

*Tanzania has an estimated 20,000 people engaged in seaweed farming. nla: Information not available.

Visits to study sites

Introduction

During the following 8 days the participants visited a range of study sites including University facilities, Government fish farming stations, small-scale fish farms and larger scale commercial fish farms. The visits were organised according to themes, as follows:

Day	Theme	Location
1	Regional facilities and requirements for research and training	Bunda College & small-holder farms near Lilongwe
2	The importance of integrated farming systems for small-holders	Freedom Farms, Dowa
3	Experiences from a focussed aquaculture development project	Central & Northern Regions Aquaculture Centre, **Mzuzu** and farms around **Mzuzu**
4	Aquaculture as part of an integrated rural development project	Extension stations at Nchenachena and Mphompha and surrounding farms
5	Irrigation schemes	Limphasa Station near Nkhata Bay
6	Rest day	Optional visit to commercial fish farm at Club Makakola
7	On-farm research and sustainable researchlextension	National Aquaculture Centre, Domasi and nearby farms
8	Developing from small-scale to commercial	Small farms in Zomba West, President's farm nr. Ntaja and Liwonde Aquaculture Farm.

Day 1 - Regional facilities and requirements for research and training

Bunda College of Agriculture has a Department of Aquaculture and Fisheries Science which was established in the 1960s. Facilities for aquaculture research and teaching have recently been upgraded with a *$6* million grant from JICA including offices, classrooms, wet and dry laboratories, fish hatchery, water supply and recirculation systems. The aquaculture section has been designed for a capacity of 20 students per year for a 3 year degree course and will have 8 staff. It will also offer M.Sc. and Diploma level training.

The study visit participants were very impressed with the new facilities, noting that they were better than anything else in the Region. In discussion, they questioned whether enough will be done to attract students from other countries in the Region. In particular, entrance standards need to be harmonised between the different countries. Nevertheless this is a unique facility which should be the preferred choice for training Regional aquaculture personnel as the conditions are more appropriate and it should cost less than sending students to Europe, Japan or to the United States.

Day 2 - The importance of integrated farming systems for small-holders

Freedom Farms is a private landholding of 20ha reclaimed from a swampy valley. An intricate system of furrows is used in irrigating the crops. A series of 9 fish ponds is situated on one side of the farm. A variety of crops, vegetables, fruits, herbs and spices are also grown. The farm is protected from flooding by a large diversion channel dug by mechanical digger with help from the **EU** and Govt.

The participants noted the many levels of integration practised and the unique way in which water is used within the farm. The farm is operated on organic principles and the farmer has gained a national and international reputation. The main problems faced are lack of transport, reliable markets, technical assistance and capital for expansion. His fish ponds have only recently been established and while he is happy with them, and how they fit into his farming system, he has yet to benefit significantly from them.

Day 3 - Experiences from a focussed aquaculture development project

The Central and Northern Regions Aquaculture Centre was built in 1989/90 by an EU-funded project, which finished in 1995. The centre has experimental and production ponds, offices, a catfish hatchery, pig enclosure, stores and a compound feed mill. The project also built 8 satellite stations spread throughout the Central and Northern Regions. The project carried out fish culture research, training and extension and resulted in around 1500 fish farms being established in the Central and Northern Regions. The main problems with the centre have been flooding and underfunding since the project finished. At present the centre is not fully staffed and is not able to satisfy local demand for fingerlings. Future plans are to strengthen the centre through more interaction with the National Aquaculture Centre in Domasi and to operate a revolving fund so that revenue from farm activities can be used directly to fund purchase of farm inputs and extension costs.

Both of the farmers visited around **Mzuzu** started fish farming as a result of the EU project. The first has **4** ponds and a pig sty as well as fruit trees, sugar cane and cassava. He is very happy with his farming system, but feels that he

has received inadequate extension advice. He also suggested it would be very beneficial if farmers like him had a chance to visit other fish farmers through local or international study visits. The second farm was established by individual farmers building one or two ponds each in a group along a river valley at Katoto. There are now 12 ponds which have been sold by the farmers to a Lilongwe based businessman. The Fisheries Department has helped by stocking the ponds, however, the farm is being managed by untrained and poorly supervised labourers. There is no regular source of manure and the ponds were clearly under-fertilised.

Discussions after the visits focussed on the problems resulting from building up unsustainable infrastructure through projects and ways in which extension work can be made less expensive, but more effective.

Day 4 - Aquaculture as part of an integrated rural development project

Nchenachena Fish Farming station was first established in the 1950s and was renovated in 1990 by the EU-funded Central and Northern Regions Fish Farming Project. It has 17 ponds and acts as a fingerling production centre for tilapia and catfish as well as a demonstration and field training centre. Mphompha station was built in 1991 as part of the same project. Unlike Mzuzu station, there has been sustained donor-funded support for Nchenachena and Mphompha stations since 1995 from the GTZ Border Zone Development Project, which aims to support communities displaced by expansion of the Nyika National Park. **A** GTZ funded expatriate is based at Nchenachena and will be replaced by a German volunteer in early 2000. The donor support is mainly for the costs of extension work.

Current work has focussed on developing appropriate methods for farmers to spawn catfish, promotion of integrated fish and vegetable growing and the promotion of aquculture by working with schools. Two farms in Nchenachena and two in Mphompha were visited. The first Nchenachena farmer has been in production since 1989 and said that fish farming has paid for school fees, a bicycle and has provided a reliable source of fresh fish for the household. His main problems were predation by otters, drought (in 1994) and a shortage of manure. He has had some success breeding catfish on-farm. The second site in Nchenachena is a school which first built a fish pond in 1962. This activity has been revived over the last few years through the enthusiasm of one of the teachers. Besides spreading the message of fish farming to the pupils and their parents, fish sales have paid for school necessities such as chalk and exercise books. The two farms visited in Mphompha are owned by brothers, both farms operating from a diverted stream which takes water along the middle of a fairly steep hillside. There is an active fish farming association in the village, involving 45 farmers. One of the farms uses pigs as the main source of manure while the other grows vegetables.

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The visit to Nchenachena and Mphompha was seen as very stimulating by the participants. These are experienced fish farmers who are definitely benefiting from aquaculture, despite having to contend with low winter temperatures and geographical isolation. The importance of sustained extension support was readily apparent when compared with the situation in Mzuzu. Concern was expressed that trials on new techniques for spawning catfish had not been fully tested on-station before being tested by farmers.

Day 5 - Irrigation schemes

Limphasa Station was built as part of the EU Project, with the aim of demonstrating the concept of fish culture within irrigation schemes. It also has the advantage of being 700m lower than Mzuzu resulting in much higher water temperatures. Extension staff based at Limphasa continue to support 100+ fish farmers in surrounding areas, but are unable to provide full coverage because their travel claims are rarely reimbursed. Over the 10 years since it was built, Limphasa Station has provided thousands of fingerlings and has been used for conditioning catfish broodstock. It has suffered from water supply problems, with frequent flooding and drought in 1994 when the irrigation scheme intake was damaged.

Day 7 - On-farm research and sustainable research/extension

The National Aquaculture Centre at Domasi, near Zomba was established in 1962 and has expanded over the years to form a complex with 125 ponds (7 ha), laboratories, hatchery, laboratory, computer room and library. It has received substantial support from **GTZ,** ICLARM and more recently ALCOM and JICA for research, extension, and infrastructure. The main research focus at present is on the development of culture techniques for indigenous fish species, particularly cyprinids. It also acts as the base for aquaculture extension in the Southern Region. Although extension is under-funded at present, a revolving fund is being set up which will allow profits from production ponds to be used to subsidise direct costs such as fuel and allowances.

Two farms which have participated in on-farm research trials were visited. One farm has been in production since the 1970s and said that the profits from fish farming had paid for his children's education as well as allowing him to buy fertiliser for crops, a bicycle and a radio. He also grows cassava, napier grass and maize and uses crop residues as feed and compost for his 6 ponds. The other farm has only recently been developed as a livestock farm with sheep, cattle, pigs and guinea fowl. His main problem is that he has no gravity supply of water for his 7 ponds and has to pump water from wells.

Day 8 - Developing from small-scale to commercial

The first two visits were to small-scale farmers in-Zomba West, one of the most highly developed areas for fish farming in Malawi with 125 farmers, **203** ponds and several fish farming clubs. Most farms receive plentiful supplies of water from streams coming from Zomba Plateau. The first farmer has successfully channelled water to his site, however his ponds must be constantly topped up because of heavy seepage. He has received grants from World Vision which he intended to spend on cement to stop the seepage. The participants advised him against this and suggested that very heavy applications of manure may seal the ponds. The second farmer has been much more successful. He has given up growing other crops and has concentrated on fish culture so that he now has 7 ponds covering $1400m^2$.

The next visits were to large scale projects. Nauninje Farm is owned by the President of Malawi and has a 5-10 ha reservoir which has been used for fish production. There is also an intensive poultry production unit at the site and it is intended to build ponds for integrated fish production. Liwonde Aquaculture Farm has 7 ha of ponds and a small outdoor hatchery complex fed with water pumped from the adjacent Shire River. After initial management problems, the farm now has close collaboration with the National Aquaculture Centre. Catfish have been introduced and a brreding programme has been very successful with 7000 fingerlings produced last season. The farm has managed to pay off initial loans and is now making profits from selling fish locally and to Zomba and Blantyre markets.

Concluding Workshop

Introduction

The study visit finished with a two day workshop in Lilongwe during which the status of Malawian fish farming was discussed, the lessons learnt were elaborated and recommendations were developed. Each of the participants also presented action plans for activities which they intend to implement on return to their normal posts, as a result of their experiences during the study visit.

Lessons learnt

The participants split into three groups to discuss the lessons which have been learnt during the study visit. These groups were:

- Extension
- Research and Professional Training
- Institutional Environment

Of course there was considerable overlap between the interests of each group therefore they were asked to consider their topics as a first priority, after which they could add points from other subject areas. After group discussions, each group presented their findings in a plenary session to the other groups and a master list of agreed lessons was drawn up. This was as follows:

- **A** strategic spread of, and sustained support for, extension services contributes to the promotion of small-scale aquaculture nation-wide.
- Informal farmer to farmer dissemination of information encourages and promotes small-scale aquaculture in communities.
- There is a potential risk of failure when unproven technology is transferred to farmers before being thoroughly tested in research stations.
- Strategically located seed production centres, either Government or privately owned, are crucial to the success of aquaculture production.
- Small-scale aquaculture production is more easily sustained if it is integrated into existing farming systems.
- Socio-economic research is a vital component in aquaculture development.
- A multidisciplinary approach to professional training is necessary for the sustainable development of aquaculture.

Action Plans

A wide range of action plans were proposed by participants as a result of their experiences during the study visit:

- Strengthen aquaculture extension delivery country-wide and stimulate the private sector to produce fingerlings in collaboration with all stake-holders. (Malawi - D.Jamu, A. Maluwa, M. Kapaleta, S.Kulankhwa)
- Promote integrated aquaculture/irrigation and eventually a study visit to Freedom Farms, Dowa, Malawi (Zambia - C.Maguswi, B.Mulonda).
- Promote private sector seed production (Uganda - Oworri-Wadunde, Edith Mushangire)
- Improvement of the Government fingerling production centre (Tanzania - V. Mushi).
- Assessment of the status of aquaculture in Zimbabwe (Zimbabwe - C.Mangwaya, F.Zimudzi).
- Develop factsheets for use by farmers using research findings on tilapia and catfish (Kenya - B.Omolo)
- Integration and introduction of tilapia culture in ponds and promote co-operation between extensionists and farmers (S.Africa - S.M.Maja).
- Promotion of freshwater aquaculture in areas where there is a market (Mozambique - **M.** da Silva).
- Promote research extension linkage in agro-pisciculture development in Nigeria (Nigeria - S.Williams, P.Bolorunduro)

Study visit evaluation

The participants were asked to fill in an evaluation questionnaire at the end of the study visit, rating different components on a scale of **1-5,** Poor to Excellent, as well as providing comments on other things which should have been included and more general comments. Overall the evaluation was very positive. Overall satisfaction with the study visit was given an average score of 4, with none of the participants rating it as less than 3 (good). The highest average scores for individual components were 4.6 for facilitation by the CTA consultant and 4.2 for appropriateness of the study visit sites. Lowest average scores were for per diems (3.2) and pre-visit arrangements **(3.4).**

Suggestions for things which might have been included were that the group should have contained more actual fish farmers, we should have looked at other aspects of the fishing industry and the closing sessions should have been attended by a government policy-maker. A few general comments were made, mostly commending the organisers for their efforts in organising the visit but two were critical of hotel arrangements in Lilongwe and one suggested that the programme was too tight.

Appendix 1. List of participants/Resource Persons.

Name/ Country	Function/Address	Telephone	Fax/E-Mail
Kenya			
Mr. Bethuel Oduor Omolo	Head of Station Fisheries Department Sagana Fish Farm, P.O. Box 26, Sagana, Kenya	+254-361-46041	E-mail: samaki@africaonline.co.ke Kveveric@users.africaonline.co.ke
Malawi			
Mr Alfred O. Maluwa	Head of Station, National Aquaculture Centre, P.O. Box 44, Domasi, Malawi	+265-531321	Fax: +265-522733 E-mail: alcom@malawi.net
Mr. Mike Kapeleta	Research-Extension Co-ordinator, National Aquaculture Centre, P.O. Box 44, Domasi, Malawi	+265-531216	Fax: +265-522733 E-mail: alcom@malawi.net
Mr Soulester Kalankwa	ActionAid-Malawi, P.O.Box 199, Mwanza, Malawi	+265-432258	Fax: +265-432337 E-mail: aamwanza@malawi.net
Mozambique			
Mr. Manuel Ali da Silva	Technician, Ministry of Agriculture and Fisheries, Livestock National Directorate Maputo, Mozambique	+258-1-4751841 4600501 460080	Fax: +258-1-460479 E-mail: moiana@dinap.com.mz
Nigeria			
Dr. Stella Williams	Department of Agricultural Economics, Obafemi Awolowo University, Ile-Ife, Osman State, Nigeria	+234-36-2338621 1-4925535	E-mail: swilliam@oauife.edu.ng
South Africa			
Mr. Morris S. Maja	Department of Agriculture, Land and Environment, P.O.Box 2296, Sovenga 0727, RSA	+27-15-267-0136	Fax: +27-15-295-7028 E-mail: npdale@pixie.co.za

Appendix 1. List of participants/Resource Persons.

Name/ Country	Function/Address	Telephone	Fax/E-Mail
Tanzania			
Mrs. Valerie Emil Mushi	Senior Fisheries Officer, Fisheries Division, P.O. Box 2462, Dar-es-Salaam, Tanzania	+255-51-1229301 116162	Fax: +255-51-110352 E-mail: fisheries@twiga.com
Uganda			
Mr. A. Oworri-Wadunde	Head of Station, Kajjansi Fisheries Research Station, P.O.Box 530, Kampala, Uganda	+256-077-502-966 (mobile)	Fax: +256-41-348-733 E-mail: gregory@infocom.co.ug
Miss Edith Kembabazi Mushangire	Uganda Fisheries & Fish Conservation Association (UFFCA), Plot 76 Buganda Road, PO. Box 25494 Kampala, Uganda	+256-41-347-861I 251-762	Fax: +256-41-250-579
Zambia			
Mr. Charles Maguswi	Deputy Director, Department of Fisheries Headquarters, P.O.Box 350100, Chilanga, Zambia	+260-1-2781731 278515	Fax: +260-1-278418 E-mail: piscator@zamnet.zm
Mr. Boniface Mulonda-Kalende	US Peace Corps, P.O.Box 50707, Lusaka, Zambia	+260-1-260377	Fax:+260-1-260685 E-mail: Mukale@usa.net Dirvine@zm.peacecorps.gov Motoseba@zamnet.zm
Zimbabwe			
Ms. Farayi C.B. Zimudzi	Senior Fisheries Extension Specialist AGRITEX, Box CY 639, Causeway, Harare, Zimbabwe	+263-4-7536231 091-346-885	E-mail: agriani@africaonline.co.zw
Ms. Concilia N. Mangwaya	Senior Ecologist, Kyle National Park, P.O. Box 913, Masvingo, Zimbabwe	+263-39-7684/ 62913	Fax: +263-39-7681 E-mail: alcom@harare.iafrica.com

Appendix I. List of participants/Resource Persons.

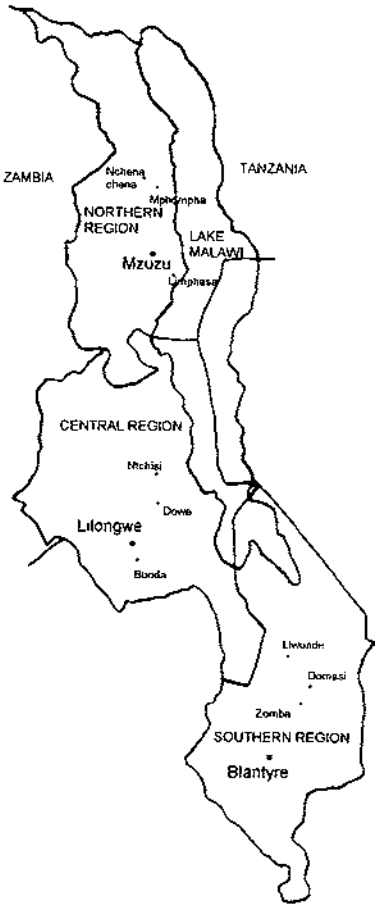
Name/ Country	Function/Address	Telephone	Fax/E-Mail
Resource Persons			
Dr. Daniel Jamu	Project leader, ICLARM-Malawi Office, P.O. **Box** 229, Zomba, Malawi	+265-532274	Fax: +265-522-733 E-mail: D.Jamu@cgiar.org
Dr. Malcolm Dickson	1 Pathfoot Drive, Bridge of Allan, Stirlingshire FK9 4SD Scotland, UK	+44-1786-833-777	Fax: +44-870-055-8517 E-mail: malcolm@pathfoot.demon.co.uk
Mr. André Vugayabagabo	Deputy Head, Depart. of Seminars and Studies, CTA, Postbus 380, 6700 AJ, Wageningen, The Netherlands	+31-317-467-158	Fax: +31-317-460-067 E-mail: vuga@cta.nl

Appendix 2. Programme.

Date/time	Activity	Location
Sunday 14th November		
	Participants arrive in Malawi	
	Overnight accommodation	Lingadzi Inn, Lilongwe
Monday 15th November		
9.00-10.30	Opening Ceremony	Lilongwe Hotel
11.00-12.00	Presentation of reports by participants	Lilongwe Hotel
12.00-1.00	Lunch	Lilongwe Hotel
1.00-5.00	Presentation of reports by participants	Lilongwe Hotel
6.00-7.00	Cocktail	Lilongwe Hotel
	Overnight accommodation	Lingadzi Inn, Lilongwe
Tuesday 16th November		
Theme — Regional facilities and requirements for research and training		
8.00	Bus leaves Lingadzi Inn	
9.00—12.00	Visit Bunda College	Near Lilongwe
12.00—1.00	Lunch	
1.00—3.00	Visit farmers	Bunda/Lilongwe
	Overnight accommodation	Lingadzi Inn
Wednesday 17th November		
Theme — The importance of integrated farming systems for smallholders		
8.00	**Bus** leaves Lingadzi Inn	
10.00—12.00	Visit farmers	Dowa/Ntchisi
12.00—1.00	Lunch	
5.00	Arrive Mzuzu	
	Overnight accommodation	**Mzuzu** Hotel
Thursday 18th November		
Theme — Experiences from a focussed aquaculture development project		
9.00—12.00	C&N Regions Aquaculture Centre	Mzuzu
12.00—1.00	Lunch	
1.00—4.00	Visit farmers	Mzuzu area
	Overnight accommodation	Mzuzu Hotel
Friday 19th November		
Theme — Aquaculture as part of an integrated rural development project		
8.00	Bus leaves Mzuzu Hotel	
10.00—12.00	Visit farmers and station	Nchenachena
12.00—1.00	Lunch	
1.00—4.00	Visit farmers and station	Mphompha
	Overnight accommodation	Mzuzu Hotel
Saturday 20th November		
Themes — Aquaculture in irrigation projects/Commercial aquaculture		
8.00	Bus leaves Mzuzu Hotel	Limphasa
9.00—10.00	Fish farming station	
2.00—3.00	Lunch	
5.00—6.00	Visit Club Makakola Fish Farm	Salima area
	Overnight accommodation	Sun 'n Sand Holiday Resort, Mangochi

Appendix 2. (continued) Programme.

Date/time	Activity	Location
Sunday 2 lst November		
	Rest Day	Mangochi
	Overnight accommodation	Sun 'n Sand Resort
Monday 22nd November		
Themes — On-farm research/Sustainable research and extension		
8.00	Bus leaves Mangochi	
10.30—12.00	National Aquaculture Centre	Domasi
12.00—1.00	Lunch	
1.00—4.00	Visit farmers	Domasi/Zomba
	Overnight accommodation	Govt Hostel, Zomba
Tuesday 23rd November		
Theme — Developing from small-scale to commercial		
7.30	Bus leaves Zomba	
8.30—10.30	Visit Chinseu fish farmers	Chinseu
10.30—12.00	Visit Nainunje Farm	Nr. Liwonde
12.00—1.00	Lunch	
1.00—3.00	Visit Liwonde Fish Farm (R. Nathanie)	Liwonde
	Overnight accommodation	Lingadzi Inn, Lilongwe
Wednesday 24th November		
9.00—12.00	Group discussions	
12.00—1.00	Lunch	
1.00—4.00	Group presentations	
	Overnight accommodation	Lingadzi Inn, Lilongwe
Thursday, 25th November		
9.00—12.00	- Summary of conclusions and recommendations, - Lessons learnt, study visit impact activities, - Evaluation of the study visit	
12.00—1.00	Lunch	
3.00—5.00	Closing ceremony - ICLARM-MALAWI - CTA - Ministry of Fisheries and Forestry	



Appendix 3. **Map of Malawi**